Alberta AGRICULTURE

AGRICULTURAL RESEARCH IN ALBERTA:

The Contributions of the Farming for the Future Program

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I Special Crops

Introduction

FARMING FOR THE FUTURE was created by the Government of Alberta in 1977 to provide additional funding for agricultural research. The objectives of Farming for the Future are to improve the long-term viability of agriculture and to improve net farm income. Thus far, more than 700 research and on-farm demonstration projects have been funded for a total cost of $40 million.

The purpose of this bulletin is to review and discuss the research on special crops which has been funded by Farming for the Future. Researchers from universities, governments and private industry have received funding from this program for projects ranging from plant breeding to disease control.

'Special crops' — such as vegetables, lentils, sugar beets, safflower, peas, potatoes, shrubs, and flowers — are alternatives to conventional crops. Producers in Alberta have recognized the opportunities in special crop production: in 1977, only 139,000 acres were planted to special crops, while estimates for 1986 and 1987 are 216,500 and 353,500 acres, respectively! Special crops also offer opportunities for the development of secondary (processing) industries in communities throughout Alberta.

Sugar Beets

Sugar beets have been an important crop in southern Alberta, adding significantly to the income of irrigated farms.

Sugar beets are harvested and stored in large piles prior to processing. During this period, there is some loss of sugar due to respiration of the beet roots. Research done in other parts of the world has shown that injuries to the beets caused by handling and dropping during piling increase the amount of sugar loss due to respiration.

In a trial conducted by Dr. Peter Bergen and funded by Farming for the Future, truck-mounted rope cushions were used to reduce the damage caused to beets during handling. However, Dr. Bergen found that beets transported on cushion-equipped trucks lost as much sugar from respiration as beets handled in the conventional way. Unfortunately, the researchers were unable to repeat the experiment, since no beets were grown in the following year (1985). The results of this experiment are considered, therefore, as tentative and not conclusive.

Vegetables

Dr. Ed Toop of the University of Alberta conducted an experiment to determine if the total yields of a conventional greenhouse crop could be significantly increased by controlling environmental factors. He grew five lettuce cultivars using a nutrient film and a completely controlled environment and found that adding carbon dioxide (CO_2) to the controlled environment at the rate of either 1000 or 2000 ppm increased the yield of lettuce. (Since the yields at 1000 and 2000 ppm were similar, he concluded that the optimal CO_2 level is approximately 1000 ppm.) When cultivars susceptible to tipburn were tested, the incidence of tipburn increased as the CO_2 level increased.

Various cultivars and lettuce types were tested in nutrient films and in individual carton containers, using the same nutrient solution and growing conditions. A "marketability index" (fresh top weight divided by tipburn rating) was calculated for each cultivar. Dr. Toop found that plants in cartons almost always had higher marketability indices and higher dry-root weights than plants in nutrient film.

As part of this project, detailed information and references on lettuce and Chinese cabbage were entered into the SPIRES computer system which is available to the public at the University of Alberta. References on the following topics were also entered on the SPIRES system: phytotrons, artificial lighting, designs for plant factories, hydroponics, culture of lettuce and Chinese cabbage, cultivar information, tip burn, simulation models and energy conservation.

Potatoes

Growing Potatoes

The physiological age of seed potatoes at the time of planting is an important factor in potato production. According to Dr. W.T. Andrew of the University of Alberta excessive aging of seed potatoes can cause premature tuber formation, weaker mainstems, multiple sprouting and reduced yield. The physiological age of a potato tuber is not the same as chronological age: storage conditions and the amount of bruising or mechanical damage during harvest will affect the rate at which potatoes age physiologically.

Until recently, tests used to assess aging have been inade-

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quate. Dr. Andrew, with the help of Farming for the Future, investigated the use of a tetrazolium (TZ) test to assess the physiological age of potato tubers. In this test a chemical (2,3,5-triphenyl tetrazolium chloride) is applied to the inside face of a cut portion of a tuber. As potatoes age, their metabolic and enzyme activities increase. The amount of color development and penetration of the TZ solution reflects the amount of enzyme present and, hence, is an indicator of physiological age. The TZ is used as a quick method for the assessment of germination and vigor of many agricultural seeds: but it had not been used for potatoes. Dr. Andrew found that depth of color penetration after TZ treatment was highly correlated with physiological age and tuber yield. He suggested that a simple TZ test could be carried out on farms to assess seed potatoes for physiological age. However, he felt that more work should be done on refining the procedure.

Regional Potato Testing

In order to keep our potato industry competitive and efficient, new cultivars which are adapted to Alberta conditions are required. In this project, conducted by Dr. D.R. Lynch of Agriculture Canada, advanced clones were tested in Lethbridge for freedom from bacterial, viral and viroid pathogens to ensure 'disease-free' material. Disease-tested lines were then multiplied at the Alberta Horticultural Research Center and compared in trials at Lethbridge and Edmonton, along with lines from co-operating programs in the north-central United States and the Pacific Northwest.

This project resulted in the identification of several promising French fry and chipping lines; these will be evaluated by the industry and perhaps licensed later.

Diseases of Potatoes

Potatoes are susceptible to a wide variety of diseases. Diseases in potatoes are often transmitted via the tubers. Thus, potatoes used for seed must be free of disease in order to avoid outbreaks of particular diseases. Seed potatoes are grown and certified according to strict standards.

Unfortunately, potato tubers may carry disease organisms without showing symptoms of the disease. Therefore, visual assessment of seed potatoes is not an adequate disease-screening method.

Canadian scientists are working on new methods for disease detection. Dr. Solke DeBoer, a researcher with Agriculture Canada in Vancouver, has used advanced biotechnological techniques to develop a new method for detecting the presence of two major disease-causing organisms in potatoes.

Bacterial ring rot is a disease of potatoes which causes wilting of leaves and rotting of tubers. Prevention is the only control for this disease: and prevention means using disease-free seed. However, the bacteria (*Corynebacterium sepedonicum*) can exist in potatoes for one or two generations without visible symptoms of the disease! Scientists and regulators needed a specific and accurate test for the presence of bacterial ring rot. Dr. DeBoer produced a 'monoclonal antibody' for the bacterium which causes this disease. (An antibody is a substance produced by body tissue as a reaction to the introduction of a foreign substance; monoclonal antibodies are identical antibodies produced by specific cells in the laboratory.)

The production of large quantities of identical (monoclonal) antibodies allows the researchers to use these antibodies in specific tests for bacterial ring rot, both for confirmation of the disease and for the detection of it in apparently healthy seed potatoes.

Dr. DeBoer has also produced monoclonal antibodies for potato leaf roll and several other potato diseases. Leaf roll, caused by a virus which is spread by aphids, reduces tuber yield drastically. Symptoms do not appear the same year that the virus is spread and the tubers carrying the virus to next year's crop do not show visual symptoms. Prior to the development of monoclonal antibodies to this disease, a bioassay test involving a large number of plants and a long period of time was used for detection. Now, rapid, accurate serological assays using monoclonal antibodies can be used to test for potato leaf roll diseases.

According to Dr. DeBoer, there is a possibility of testing for all the major potato viruses in one simple test! Further work in this area will be essential to eliminating virus diseases from commercial potato production and allowing for higher productivity and increased exports of potatoes.

Dr. C. Hiruki of the University of Alberta developed and evaluated practical diagnostic procedures for potato spindle tuber viroid disease. Conventional methods of detecting this disease in seed potatoes have not been totally effective. Hiruki used sophisticated genetic engineering techniques in his project to detect minute amounts of viroid nucleic acids. He was able to make significant improvements in the procedure for diagnosis of potato spindle tuber viroid disease.

Tree and Fruit Production

Dr. Hugh Knowles of the University of Alberta, evaluated the effects of spacing, applied nitrogen and moisture on the growth and roduction of seven commonly grown nursery trees (American Elm, Green Ash, Black Ash, Ussurian Pear, American Mountain Ash, Scots' Pine and White Spruce).

Fertilizer applied to the soil beneath trees usually does not give a growth response until the following year. However, in this study, two species (Green Ash and Black Ash) showed a negative response to applied nitrogen while only one species (American Elm) showed a positive response.

Tree spacing had no effect on growth.

Growth characteristics and pruning requirements of the seven species were examined in this study. Over the four-year period, deciduous trees achieved the highest average heights (e.g., American Elm — 2.35 m, Black Ash — 1.83 m, and Green Ash — 1.69 m) as compared to the conifers (Scots' Pine — 1.4 m, and White Spruce — 1.14 m). Annual extension growth of one deciduous and two conferous species were recorded. In all cases, growth was slow and steady for the first three years and rapid in the fourth year.

Fruit production — usually Saskatoons — has become a popular and profitable crop in some areas of Alberta. Dr. R.E. Harris, a private researcher from Victoria, investigated the rapid propagation of this crop. When Dr. Harris started work in this area, saskatoons could not be propogated vegetatively by traditional methods. As a result, uniform ripening, high quality orchards that could be picked mechanically could not be established. A hydroponic in vitro ('lab bench') system had been developed by Agriculture Canada, but it required modification.

The objectives of this project were to determine the optimum conditions for establishing and multiplying saskatoons in the laboratory and to determine the effects of variables used in the multiplication stage on subsequent rooting of the shoots. He hoped to develop methods which would result in rooting of at least 90 per cent of the shoots produced *in vitro* and prevention of dormancy in the shoots after rooting.

Dr. Harris identified the following basic conditions for rooting: a 24-hour photoperiod; 2400 one-light intensity under cool, white fluorescent lights; 23°C air temperatures; and, 0.005 umol IBA incorporated in the rooting medium. He also found that actively growing shoots five centimetres or longer with two or more normal-shaped leaves root and grow better than shorter shoots, or shoots with narrow, dark-green leaves.

Soybeans and Safflower

Dr. H. Muendel, a plant breeder with Agriculture Canada in Lethbridge, began in 1978 to investigate the potentials offered by two special crops — soybeans and safflower.

Soybeans can be used to produce edible oil, a high protein meal, and a variety of specialty foods. While some soybeans are grown in Ontario, Canada imports half of the soybeans used in this country. This crop fixes nitrogen in the soil and, therefore, does not require nitrogen fertilizer.

Safflower seed is grown for its high quality edible oil; it is also used as birdseed. It has a deep taproot, which makes it suitable for intensive dryland cropping.

Dr. Muendel's breeding programs have focused on, first, developing soybean varieties suitable for irrigated Alberta conditions and, second, developing safflower varieties which are suitable for dryland production.

Muendel was successful in developing experimental lines of soybeans which yielded 1900-2500 kg/ha (30-40 bu/acre). He predicts that the Alberta-bred soybean varieties will be available in several years. Soybeans will be an alternative crop for irrigation farmers in Alberta.

The breeding program for safflower progressed well during this project. Selections made in Alberta were two weeks earlier in maturity than standard American varieties. Other goals of the breeding program were high yield, rust resistance and high oil levels. The early-maturing selections yielded 2000 kg/ha in research plots. Muendel stated in the final report for this project that "... early-maturing, high-oil, rust-resistant varieties suitable for the dryland southern prairies can be anticipated from the program initiated here."

Flowers

Farmers and acreage owners are interested in alternative, profitable crops. According to Buck Godwin, an instructor in horticulture at Olds College, one of the most obvious alternative crops for Alberta producers is cut flowers! Currently, Albertans import cut flowers from Holland, the United States, South America, Hawaii and Israel. Godwin received funding from Farming for the Future to investigate commercial field production of selected flower crops for the Alberta fresh flower market as well as dried flowers and other Plants.

The flowers grown included *Centaurea cyanus* (Cornflower cv. Tall Mix and Polka Dot), *Delphinium consolida*, *Gypsophila elegans*, *Helichrysum bracteatum monstrosum*, *Zinnia* sp., *Nigella damascena*, *Limonium sinuatum* and *Molucella laevis* (Bells of Ireland). Godwin's final report on this project includes detailed information on growing, harvesting and marketing these species and others. In his opinion "... the field production of most species included in the test is entirely feasible and the technology of production is well in hand!"

Godwin's work on dried flowers (and other plants) was also very interesting. Prior to this project, he estimated that 90 per cent of the dried ornamental plants used in Alberta were imported from other contries. This project involved growing, preserving and marketing crops ranging from common grains and grasses to sorghum and ornamental safflower. His final report includes information on the use of dyes to make these plants more attractive and a "Production Guide" with information on how to grow, harvest and dye plants such as flax, foxtail, durum wheat and canary grass.

Godwin concluded that "domestic production should be able to satisfy a substantial measure of the Canadian market and, with experienced, energetic producers may well reverse the product flow and move into an export situation."

Other Special Crops

Researchers and farmers have known for some time that Alberta cannot depend on just a few agricultural crops. As a result, research and on-farm trials using a variety of unusual crops have been conducted during the past years and are continuing at an accelerating rate.

Dr. R. Gaudiel, a scientist with Alberta Agriculture, evaluated some of the new and unusual crops which might be grown profitably in central and south-central Alberta.

Various crops, including field peas, lentils, canary seed, buck-wheat and sunflower, were seeded at several sites.

Dr. Gaudiel's conclusions were as follows:

- Available early fababean lines can be used effectively in central Alberta.
- Century, "the standard field pea variety", is early enough to be grown successfully in central Alberta.
- Eston is the best variety of lentils for central Alberta, whereas Laird is the best lentil variety for drier areas.
- While some oil-seed sunflowers are early enough for the Dark Brown soils south of Drumheller, confectionary sunflowers are suitable only in the Dark Brown soil zone where the growing season is longer.
- Canary seed and buckwheat can be grown in the Dark Brown soil zone.

- Chickpeas can be grown effectively in only the irrigated, high temperature areas of southern Alberta.

New varieties and lines of these special crops must be tested regularly in central Alberta, according to Gaudiel. Special emphasis should be given to early maturing varieties of these crops for this area.

Special crops require special management, but, according to Dr. Gaudiel, the potential benefits are great. Growing crops, such as those tested in this project, has numerous benefits:

1. Diversifying results in more stability of income (when the selling price of wheat is low, the selling price of lentils may be high).
2. Special crops can often be planted earlier or harvested later than regular crops.
3. Rotations with special crops are often beneficial to the soil — especially when nitrogen-fixing legumes are involved .
4. Some special crops, such as fababeans and peas, can produce high quality silage or high-protein seed for livestock.

Dr. Gaudiel — and an increasing number of Alberta farmers — are very enthusiastic about the potential for special crops. Funding by Farming for the Future and other agencies is essential to ensure that research in this area will continue.

References and Further Readings

Copies of final reports for Farming for the Future may be obtained from:

Alberta Agriculture
Research Division
7000 -113 Street
Edmonton, Alberta
T6H 5T6

Copies of brochures and other publications are available from Alberta Agriculture's Publications Office (at the above address) or from local district agriculturists.

Farming for the Future

RESEARCH REPORT. A newsletter (10 issues/year) which focuses on the results of Farming for the Future research and on-farm demonstration projects.

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